

REMARKS

Claims 2-5, 9, 10 and 14-16 are pending. Favorable reconsideration is respectfully requested.

The present invention relates to a process for producing a purified resist polymer solution, comprising:

(1) dissolving a solid product comprising a resist polymer comprising a repeating unit decomposable by, and becoming alkali-soluble by, the action of an acid and a polar group-containing repeating unit, in a solvent having a boiling point at atmospheric pressure not higher than the boiling point of a solvent for coating-film formation, and

(2) evaporating from the solution obtained in (1) the solvent having a boiling point at atmospheric pressure not higher than the boiling point of the solvent for coating-film formation while adding, under reduced pressure with the temperature being controlled at 70°C or less, a solvent for coating-film formation to produce a purified resist polymer solution,

where the amount of impurities having a boiling point at atmospheric pressure of not more than the boiling point of the solvents for coating-film formation is 1 mass% or less of the resist polymer in the purified resist polymer solution.

See Claim 14.

The rejections of the claims under 35 U.S.C. §103(a) over Sounik in view of Sehm, Zampini and Breyta are respectfully traversed. The claimed purified resist polymer is not suggested by these references.

(1) Polymers

The polymer obtained with the claimed process is CAR (Chemically Amplified Resist). CAR has been adopted in lithographic technology using a KrF (krypton fluoride) and ArF (argon fluoride) excimer laser which has a short wavelength of 248nm and 193nm,

respectively. Its structure differs from conventionally-used novolac resist with respect to the following points.

- (i) Chemically Amplified Resist (CAR) comprises:
  - (i-1) a polymeric component which has acid-dissociable protective group and becomes alkali-soluble, thereby becoming soluble to a developer (this requires use of transparent light source and characteristics such as resistivity to etchant);
  - (i-2) photoacid generator which generates acid by the action of light and acts as a catalyst for above (i-1); and
  - (i-3) solvent and other additives.
- (ii) Novolac resist comprises:
  - (ii-1) a polymeric component which has an alkali-soluble group and is soluble to an alkaline-developer;
  - (ii-2) an additive which becomes alkali-soluble by the action of light and becomes soluble to a developer (for example, naphthoquinone diazide); and
  - (ii-3) solvent and other additives.

In view of the foregoing, the structures of these polymers are different. Further, the alkali-soluble protective group of CAR polymer dissociates by the action of other acids or excess heat, which does not occur in the case of novolac resist. Therefore, solely applying the lithographic technology for novolac resist to a different type of resist such as CAR polymer does not bring desirable results.

(2) Sounik

The polymer used by Sounik is the CAR polymer which is the same as that used in the present invention. Further, Sounik uses carboxylic alcohol for polymerization solution in the polymerization step and for the first solvent in the purification step (page 5, paragraph

[0101]). Sounik further teaches use of the second solvent which includes hexane, heptane and the like (see page 5, paragraph [0115] and [0117] of Sounik) in the purification step conducted after the polymerization step and before the catalyst removal step. In the solvent exchange step, Sounik uses a third solvent which is an aprotic/organic solvent.

In the present invention, methyl ethyl ketone (MEK) and the like are used as solvent (b) which corresponds to the first solvent of Sounik, both having a boiling point at atmospheric pressure not higher than the boiling point of solvent for coating-film formation. The third solvent used by Sounik is an aprotic/organic solvent and includes PGMEA and the like which are used as solvent (a) for coating-film formation in the present application. however, in the present invention precipitation is conducted using hydrous methanol, there is no disclosure of use of a solvent corresponding to the second solvent of Sounik, nor is there corresponding solvent extraction step. In view of the above, the purification process of the present invention is not obvious from the teaching of Sounik.

(3) Sehm

The polymer used by Sehm is cross-linked carboxyl acid polymer which is different from the CAR polymer used in the present invention. The polymerization solvent used by Sehm includes MEK, however, it is capable of dissolving only monomers but not polymers. On the other hand, the solvent used in the polymerization step of the present invention can dissolve both monomers and polymers (see column 5, line 56 to column 6, line 11 of Sehm).

Further, Sehm uses minerals spirits as a solvent for removing the polymerization solvent. It is clearly understood that such mineral spirits are different from solvent (a) used in the present application.

As you may see from the above comparison, the inventions of the present application and Sehm are quite different in terms of the polymers used, properties of the solvent used for

polymerization and the solvent used to remove the polymerization solvent. Therefore, the present invention should not be obvious from the disclosure of Sehm.

(4) Zampini

Zampini uses novolac resin of cresol and salicylaldehyde, whereas in the present invention, CAR polymer of an acrylic monomer is used. The solvent used to polymerize cresol and salicylaldehyde is an acidic soluble solvent, which of course has different properties from MEK and the like used as solvent (b) of the present invention.

Zampini teaches, as a desirable method of removing unwanted solvent, diluting the solution with photoresist solvent and then vacuum distilling. However, applicability of such method to the present application is doubtful because the polymers used, namely their structures, are different between the two inventions. Moreover, the method is not specifically described in the Examples. Further, Zampini does not mention conducting the removing step under reduced pressure of 70°C or lower. As specified in Claim 14 of the present application, the removing step is conducted under reduced pressure of 70°C or lower.

(5) Breyta

Breyta has been cited its disclosure that p-hydroxystyrene/methacrylate copolymers may be dissolved in acetone. See page 7 of the Office Action.

(6) Combination of References

(i) It is obvious that if the polymers having different structures, the method of purification of respective polymers should vary accordingly. This is because functional groups of the respective polymers are expected to modify due to polymer dissolution.

(ii) As discussed above, Zampini uses a novolac resin of cresol and salicylaldehyde, whereas the present invention uses CAR polymer of acrylic monomer. The polymers have different binding. Further, as explained above in (1), CAR polymer has acid-dissociable protective group and becomes alkali-soluble whereas novolac polymer originally

has an alkali-soluble group. Since the polymers used are totally different in their structures, the method of purification should different accordingly considering the properties of respective polymers. Therefore, the purification technology used for novolac resin can not be entirely applied to purification of CAR resin. In view of this, there is no motivation to combine the inventions of Zampini and Sounik. Even if the disclosures of those references were combined, the invention of Sounik is significantly different from the present invention and description of Zampini lack materiality, the present invention is not conceivable from these references.

(iii) Regarding disclosure of Sehm, a cross-linked carboxyl acid polymer has different structure from CAR resin used in the present invention which has acid-dissociable protective group and becomes alkali-soluble. It is known that existence of such protective group has influence on the purification process using a solvent, and thus purification process should differ according to the type of polymer to be purified. In view of this, the purification process of Sehm can not be directly applied for purification of CAR polymer taught by Sounik, and there is no motivation to combine the two inventions. Further, as explained above, Sehm differs from the present invention in the type of polymer used, solvent to be used in polymerization and solvent to remove the polymerization solvent and so, the present invention would not be suggested even if the inventions of Sehm and Sounik were to be combined.

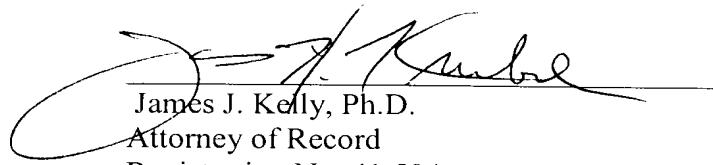
(iv) Most significantly, none of the references teach conducting the removing step under a reduced pressure of 70°C or lower. In the claimed process, solvent removing step is conducted under reduced pressure of 70°C or lower so that the protective group is not dissociated, and the amount of impurities having low boiling points can be sufficiently lowered in a short period of time.

In view of the foregoing, the claimed process is not suggested over the combination of Sounik in view of Sehm, Zampini and Breyta. Accordingly, the claimed subject matter is not obvious over those reference taken in combination. Withdrawal of this ground of rejection is respectfully requested.

Applicants submit that the present application is in condition for allowance. Early notice to this effect is earnestly solicited.

Respectfully submitted,

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